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ORIGINAL RESEARCH

CARDIO-OBSTETRICS

Management of Postpartum Preeclampsia and Hypertensive Disorders (MOPP)

Postpartum Tight vs Standard Blood Pressure Control

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ABSTRACT

BACKGROUND It is unknown whether tightly controlled blood pressure in the postpartum period will improve outcomes.

OBJECTIVES The purpose of this study was to assess the effect of a lower treatment threshold (≥130/80 mm Hg) for initiating and titrating antihypertensive medication on reducing emergency department visits in postpartum patients with hypertension.

METHODS A prospective cohort of postpartum patients was recruited in a multicenter study between March 2023 and March 2024 and treated to maintain blood pressure <130/80 mm Hg using remote blood pressure monitoring. These patients were compared to a propensity score-matched retrospective cohort from February 2021 to February 2023 who were treated to maintain blood pressures <150/100 mm Hg. Eligible patients were 18 or older with a diagnosis of hypertensive disorder. The primary outcome was an emergency department visit for hypertension.

RESULTS There were 392 patients enrolled in the interventional cohort and 1,204 patients identified in the retrospective cohort. After the propensity score match, 276 and 429 patients remained in the prospective and retrospective groups, respectively. Emergency department visits for hypertensive disorders occurred in 10 patients (3.6%) in the intervention and 36 patients (8.4%) in the retrospective cohort (risk difference −4.8; 95% CI: −8.2 to −1.3; doubly robust OR: 0.32; 95% CI: 0.10-1.01). At 6 weeks postpartum, compared to the retrospective group, the intervention group had systolic and diastolic blood pressure that was 4.4 mm Hg (95% CI: −6.8 to −2.0) and 3.1 mm Hg (95% CI: −4.9 to −1.2) lower, respectively.

CONCLUSIONS Tighter blood pressure control was associated with reduced postpartum emergency department visits for hypertensive disorders. (JACC Adv. 2025;4:101617) © 2025 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

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ABBREVIATIONS AND ACRONYMS

ACOG = American College of Obstetricians and Gynecologists

AHA = American Heart Association

BP = blood pressure

MOPP = management of postpartum preeclampsia and hypertensive disorders

RD = risk differences

In the United States, 3% to 6% of all pregnancies are complicated by preeclampsia, and 5% to 12% of those patients return to the hospital with hypertensive disorders when they are postpartum.[1,2] Black pregnant persons are especially vulnerable to antepartum and postpartum preeclampsia and have higher rates of morbidity and mortality compared to their White counterparts.[3] The prevalence of hypertension is increasing,[4] and it is one of the most substantial modifiable risk factors for cardiovascular disease.[5] Tight blood pressure control in the postpartum period may decrease the risk of cardiovascular disease later in life.[6,7]

The current guidelines from the American College of Obstetricians and Gynecologists for managing postpartum hypertension are based on a 1987 case series of 67 patients and recommend a cutoff of 150/100 mm Hg to start antihypertensive medications in the postpartum period.[8-10] Outside of pregnancy, new guidelines and recommendations for blood pressure control have shown that a reduction in blood pressure decreases cardiovascular events.[11] As a result of these findings, the 2017 American College of Cardiology and American Heart Association (AHA) Blood Pressure Guidelines recommend systolic and diastolic blood pressure treatment goals of <130 mm Hg and <80 mm Hg, respectively, for nonpregnant adults on antihypertensive medication.[12]

Tita et al[13] reported that tight blood pressure control to <140/90 mm Hg during the antepartum period for patients with chronic hypertension improved maternal and neonatal outcomes. Limited studies have evaluated the effects of a lower blood pressure target and stricter blood pressure control during the postpartum period to reduce complications of preeclampsia and its severe sequelae. However, without the safety concerns for the fetus, the postpartum period presents an optimal opportunity to assess if tighter blood pressure control may be beneficial.

More than 60% of maternal deaths occur during the postpartum period, of which hypertension is a major contributor to these deaths.[14] Postpartum blood pressure most typically reaches a maximum at 4 to 6 days postpartum[15] and returns to the prepregnancy state around 4 to 6 weeks postpartum.[16] Patient self-monitoring of blood pressure has revealed that more than 80% of patients with hypertensive disorders of pregnancy have persistently elevated blood pressure.[17] Remote patient monitoring offers an innovative approach to blood pressure assessment and titration of medication for patients who do not have the resources to make frequent in-person visits.[18-20] However, in one study, the increased surveillance led to increased emergency department visits,[21] which may have been because no adjustments in therapy were accompanied by a change in monitoring. Additional emergency department visits or postpartum admissions can impact mother-infant bonding, breastfeeding, and mental health, in addition to driving up the cost of health care.[22,23]

Hypertensive disorders in pregnancy, particularly preeclampsia, are strong risk factors for cardiovascular disease along the life course.[24,25] It is plausible that reducing blood pressure through titrated medication and dosage would mitigate these cardiovascular disease risks. We hypothesized that persons with high blood pressure with an activated medication titration regimen would have reduced emergency department visits. We tested this hypothesis in a large cohort of postpartum persons using a tight blood pressure control algorithm (goal blood pressure <130/80 mm Hg) and remote blood pressure to reduce postpartum emergency department visits for hypertensive disorders.

METHODS

TRIAL DESIGN. A prospective cohort of patients who utilized remote patient monitoring to achieve tight blood pressure control was compared to a retrospective cohort of patients with standard blood pressure management using a propensity score methodology. This trial was conducted at 2 tertiary hospitals, Rutgers Robert Wood Johnson University Hospital, New Brunswick, NJ, and Cooperman Barnabas Medical Center, Livingston, NJ. Rutgers University maintained the Institutional Board Approval of record, and the study was registered with ClinicalTrials.gov (NCT05775744). The prospective cohort included patients who delivered between March 28, 2023, and

This research was presented, in part, as an oral plenary at the Society for Maternal-Fetal Medicine's 45th Annual Pregnancy Meeting in Denver, Colorado, on January 31, 2025.
The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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March 26, 2024, and they were compared to a retrospective cohort with deliveries between February 1, 2021, and February 1, 2023. Study data were collected and managed using REDCap electronic data capture tools hosted at Rutgers University.[26,27] The study followed the TREND (Transparent Reporting of Evaluations with Nonrandomized Design) reporting guidelines for nonrandomized studies.[28]

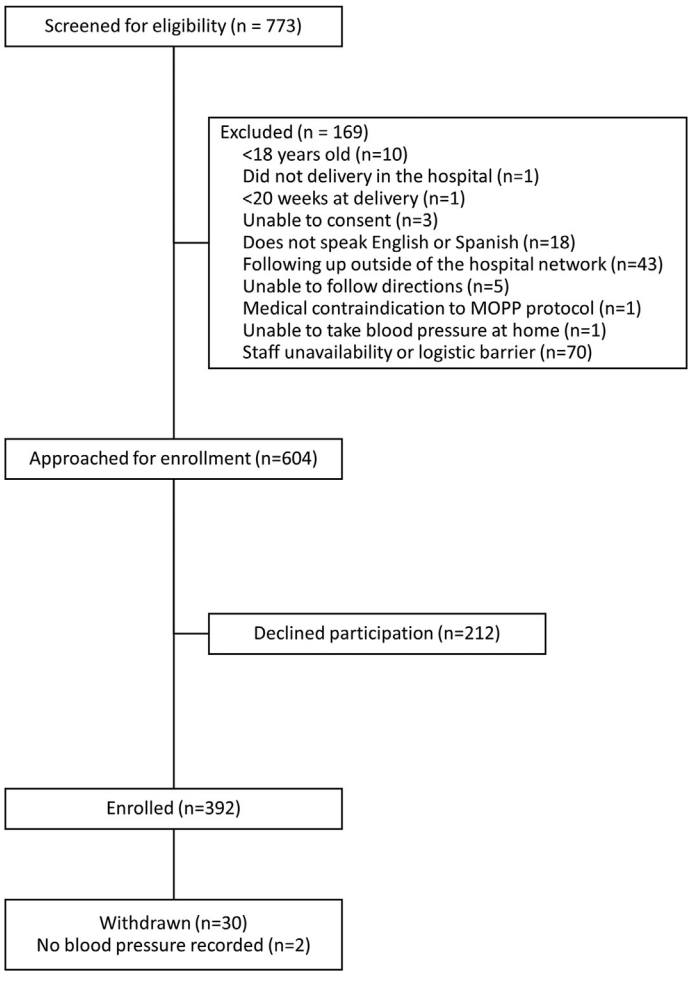
ELIGIBILITY. Patients were included if they were 18 or older and delivered at 20 weeks gestation or beyond during the current hospitalization. All subjects met the criteria for hypertensive disorders of pregnancy (chronic hypertension, gestational hypertension, or preeclampsia).[8,29] The prospective cohort was also required to consent, speak English or Spanish, follow-up with a physician associated with the hospital system, and be able to follow study protocols. Potential study subjects in the prospective arm were excluded if they had any medical condition that the providers felt was a contraindication to the treatment algorithm or were unwilling to monitor their blood pressure at home. Of the 657 patients screened, 392 were enrolled in the prospective arm (**Figure 1**). Billing codes were used to identify the patients in the retrospective arm of the study (International Classification of Diseases, version 10 codes O10-O16).

INTERVENTION AND PROCEDURES. Patients were approached and enrolled postpartum before discharge from their delivery hospitalization. Patients enrolled in the prospective arm were prescribed blood pressure medication during hospitalization to maintain a blood pressure <130/80 mm Hg. Before discharge, the patients were set up with a remote patient monitoring system and were instructed on the correct technique for measuring blood pressure. Discharge timing was left to the discretion of the admitting physician. Blood pressure readings were transferred by Bluetooth to the Health Recovery Solutions platform and were monitored by a physician at all hours of the day.

In response to recent publications, nifedipine extended release was preferentially used over labetalol,[30,31] but patients could be continued on labetalol or restarted on their prepregnancy antihypertensive medication. If patients had blood pressure ≥130/80 mm Hg, nifedipine extended release was started at 30 mg or increased by 30 mg to reach a target blood pressure of <130/80 mm Hg. Labetalol was titrated by 200 mg twice a day or 100 mg 3 times a day. Medication was decreased by one titration unit for blood pressure that was persistently <110/80 mm Hg and discontinued for blood pressure persistently <100/80 mm Hg (Supplemental Table 1). A single medication was increased to the highest tolerated dose before starting a second medication to maximize compliance.

Enrolled subjects measured their blood pressure twice daily for the first 72 hours after discharge and daily after that. Subjects were instructed to repeat their blood pressure after any abnormal readings. Patients who were normotensive for 1 week, not on medication, and >2 weeks from discharge decreased the frequency of blood pressure readings to once a week. If it had been more than 72 hours from an expected blood pressure reading, study staff would call to remind the patient to take their blood pressure. After 6 weeks, remote monitoring equipment was

FIGURE 1 Transparent Reporting of Evaluations With Nonrandomized Design (TREND) Diagram


Screened for eligibility (n = 773)
Excluded (n = 169)
<18 years old (n=10)
Did not delivery in the hospital (n=1)
<20 weeks at delivery (n=1)
Unable to consent (n=3)
Does not speak English or Spanish (n=18)
Following up outside of the hospital network (n=43)
Unable to follow directions (n=5)
Medical contraindication to MOPP protocol (n=1)
Unable to take blood pressure at home (n=1)
Staff unavailability or logistic barrier (n=70)
Approached for enrollment (n=604)
Declined participation (n=212)
Enrolled (n=392)
Withdrawn (n=30)
No blood pressure recorded (n=2)

MOPP = Management of Postpartum Preeclampsia and Hypertensive Disorders.

returned, and blood pressure management was transitioned to the patient's primary provider. The retrospective cohort did not have a uniform protocol for starting or titrating antihypertensive medications, but the clinical standard during this time was to titrate antihypertensive medication to a goal of <150/100 mm Hg.

OUTCOMES. The primary outcome was emergency department visits for hypertensive disorders. Secondary outcomes included postpartum readmissions for hypertensive disorders, blood pressure in the postpartum period, and attendance at postpartum visits.

STATISTICAL ANALYSIS. The estimated rate of emergency department visits for patients with hypertensive disorders was 12%. It was determined that 392 patients were needed to enroll in the prospective arm to provide 80% power to detect a 50% decrease in the primary outcome (assuming a 10% loss to follow-up and a 2-tailed type I error rate of 0.05).

Multiple imputations were undertaken for missing covariate data, with the pattern of missing data assumed to be "missing at random." Fifty imputed data sets were created based on the fully conditional specification method,[32] with the imputation models comprising all covariates. The standard errors were pooled and combined using Rubin's principle.[33]

A propensity score analysis was performed using the greedy matching algorithm[34] to develop pseudorandomized groups of tight blood pressure control vs usual care. Logistic regression models were used to estimate the propensity scores using covariates as predictors. Hosmer-Lemeshow goodness-of-fit was used, and no model violations were apparent. A matching algorithm created a 3-to-1 match (without replacement) of usual care vs tight blood pressure control (caliper distance of <0.1). Main effects at baseline included race/ethnicity, parity, marital status, body mass index at delivery, payer, type of hypertensive disorder, aspirin use, diabetes, type of labor, type of delivery, multifetal gestation, maternal lupus, language spoken, maternal age at delivery, gestational age at delivery, and use of magnesium sulfate for preeclampsia. Two-way interactions between maternal race with body mass index, type of hypertensive disorder, diabetes, and gestational age and between the type of hypertensive disorder with aspirin, diabetes, gestational age, type of labor, and magnesium sulfate for preeclampsia were included. We also considered other potential 2-way interactions not included in the final model. Since these interaction terms were not predictive of tight blood pressure control, these terms were dropped from the final model. The approach was to develop the best parsimonious prediction model based on available covariates. To account for institutional differences, patients from the prospective group were matched to retrospective controls from the same institution.

An intent-to-treat approach was used to estimate the risk differences (RD) and the matched pair OR with their corresponding 95% CI in the primary and secondary outcomes. In addition, doubly robust OR was reported after adjusting for confounding covariates listed in the prediction model. As a sensitivity analysis, we also performed a per-protocol analysis of the primary outcome.

SENSITIVITY ANALYSIS. Since the matching algorithm could not identify matches for 116 patients in the prospective arm, the primary analysis was replicated based on the inverse probability of the treatment weighting method. The results of the inverse probability of treatment weighting weighted propensity score match are shown in Supplemental Table 2.

Statistical analysis was performed in SAS (version 9.4, SAS Institute) and visualization using R (version 4.3.2, R Foundation for Statistical Computing).

RESULTS

From the source population of 392 patients in the prospective intervention arm and 1,204 patients in the retrospective control arm, 276 patients in the intervention arm were matched to 429 patients in the control group. Characteristics of the original cohort and propensity score matched cohort are described in **Table 1**.

Before delivery admission, in the intervention cohort, 18.8% of patients were taking antihypertensive medication. The mean highest blood pressure during pregnancy was 141.8 ± 15.6/85.2 ± 10.4 mm Hg and occurred at 30.2 ± 9.2 weeks gestation. In the control cohort, 18.2% of patients were on antihypertensive medication before delivery admission. The mean highest blood pressure was 147.8 ± 19.0/88.3 ± 11.5 mm Hg occurring at 31.3 ± 8.6 weeks gestation. Chronic hypertension was recorded in 13.0% and 8.9%, chronic hypertension with superimposed preeclampsia in 13.8% and 21.5%, preeclampsia in 45.3% and 51.5%, and gestational hypertension in 27.9% and 18.2% of the intervention group and control group, respectively. Neonatal outcomes were similar between the 2 groups (**Table 1**).

Emergency department visits with or without hospitalization for hypertensive disorders occurred in 10 patients (3.6%) in the intervention cohort and 36 patients (8.4%) in the control group (RD: −4.8;

TABLE 1 Distribution of Maternal and Neonatal Characteristics of the Original and Propensity Score-Matched Cohorts of Tight vs Standard Blood Pressure Control

	Original Cohort (n = 1,596)		Propensity Scores Matched Groups (n = 705)	
	Tight Blood Pressure Control (n = 392)	Standard Blood Pressure Control (n = 1,204)	Tight Blood Pressure Control (n = 276)	Standard Blood Pressure Control (n = 429)
Maternal age at delivery	32.2 ± 6.0	33.0 ± 5.8	32.0 ± 6.1	32.5 ± 6.1
Gestational age at delivery				
Median	37.6 ± 2.7	36.9 ± 3.1	37.3 ± 2.8	37.0 ± 3.2
<28 wk	6 (1.5)	34 (2.8)	4 (1.5)	14 (3.3)
<34 wk	30 (7.7)	164 (13.6)	27 (9.8)	56 (13.1)
<37 wk	303 (77.3)	746 (62.0)	198 (71.7)	278 (64.8)
≥37 wk	89 (22.7)	458 (38.0)	78 (28.3)	151 (35.2)
Race or ethnicity				
Non-Hispanic White	114 (29.1)	251 (20.9)	79 (28.6)	112 (26.1)
Non-Hispanic Black	84 (21.4)	162 (13.5)	54 (19.6)	90 (21.0)
Hispanic	137 (35.0)	238 (19.8)	98 (35.5)	148 (34.5)
Asian/Pacific Islander	25 (6.4)	80 (6.6)	20 (7.3)	38 (8.9)
Other	31 (7.9)	111 (9.2)	25 (9.1)	41 (9.6)
Unknown	1 (0.3)	362 (30.1)	–	–
Parity				
Nulliparous	135 (40.5)	468 (45.3)	117 (42.4)	192 (44.8)
One prior delivery	97 (29.1)	306 (29.6)	79 (28.6)	115 (26.8)
≥2 deliveries	101 (30.3)	259 (25.1)	80 (29.0)	122 (28.4)
Marital status				
Single	171 (43.6)	420 (35.1)	130 (47.1)	205 (47.8)
Married	221 (56.4)	776 (64.9)	146 (52.9)	224 (52.2)
Language spoken				
English	340 (86.7)	1,077 (90.0)	233 (84.4)	359 (83.7)
Spanish	52 (13.3)	120 (10.0)	43 (15.6)	70 (16.3)
Body mass index (kg/m^2) at delivery				
Mean (SD)	34.9 ± 7.0	34.5 ± 7.2	34.6 ± 7.3	35.1 ± 7.3
<30	93 (23.9)	279 (27.8)	73 (26.5)	99 (23.1)
30-39	216 (55.5)	531 (52.9)	151 (54.7)	235 (54.8)
≥40	80 (20.6)	194 (19.3)	52 (18.8)	95 (22.1)
Insurance status				
Private payer	169 (43.2)	299 (24.9)	146 (52.9)	237 (55.2)
Government sponsored	216 (55.2)	860 (71.6)	125 (45.3)	187 (43.6)
Self-pay	5 (1.3)	27 (2.3)	5 (1.8)	5 (1.2)
Other	1 (0.3)	16 (1.3)	–	–
Missing data	1 (0.3)	2 (0.2)	–	–
Risk factors during pregnancy				
Smoking	11 (2.8)	18 (1.5)	10 (3.6)	5 (1.2)
Alcohol use	2 (0.5)	5 (0.4)	2 (0.7)	3 (0.7)
Substance use	13 (3.3)	15 (1.6)	11 (4.0)	8 (1.9)
Aspirin use	158 (40.3)	588 (49.2)	113 (40.9)	162 (37.8)
Maternal lupus	5 (1.3)	5 (0.4)	4 (1.5)	3 (0.7)
Multifetal gestations	14 (3.6)	63 (5.2)	10 (3.6)	18 (4.2)
Diabetes	86 (22.1)	242 (20.1)	62 (22.5)	87 (20.3)
Prior to delivery admission				
Taking antihypertensive medication	69 (17.7)	183 (15.2)	52 (18.8)	78 (18.2)
Mean gestational age at highest BP	30.2 ± 9.2	29.3 ± 9 0.3	30.2 ± 9.2	31.3 ± 8.6
Mean highest systolic BP	140.4 ± 14.9	143.6 ± 18.3	141.8 ± 15.6	147.8 ± 19.0
Mean highest diastolic BP	84.5 ± 10.0	87.1 ± 11.4	85.2 ± 10.4	88.3 ± 11.5

Continued on the next page

TABLE 1 Continued

	Original Cohort (n = 1,596)		Propensity Scores Matched Groups (n = 705)	
	Tight Blood Pressure Control (n = 392)	Standard Blood Pressure Control (n = 1,204)	Tight Blood Pressure Control (n = 276)	Standard Blood Pressure Control (n = 429)
Type of labor				
None	106 (27.3)	380 (31.6)	62 (22.5)	111 (25.9)
Induced	209 (53.7)	626 (52.0)	157 (56.9)	223 (52.0)
Spontaneous	74 (19.0)	198 (16.5)	57 (20.7)	95 (22.1)
Type of delivery				
Spontaneous vaginal	189 (48.5)	538 (44.7)	139 (50.4)	201 (46.9)
Operative vaginal	24 (6.2)	45 (3.7)	15 (5.4)	19 (4.4)
Cesarean	177 (45.4)	621 (51.6)	122 (44.2)	209 (48.7)
Hypertensive disorder				
Chronic hypertension	56 (14.3)	40 (3.3)	36 (13.0)	38 (8.9)
Chronic hypertension with superimposed preeclampsia	44 (11.2)	256 (21.3)	38 (13.8)	92 (21.5)
Preeclampsia	136 (34.7)	785 (65.2)	125 (45.3)	221 (51.5)
Gestational hypertension	156 (39.8)	123 (10.2)	77 (27.9)	78 (18.2)
Feature of preeclampsia				
Proteinuria	101 (25.8)	223 (18.5)	89 (32.3)	74 (17.3)
Severe range BP	149 (38.0)	939 (78.0)	133 (48.2)	275 (64.1)
Headache	20 (5.1)	62 (5.2)	18 (6.5)	18 (4.2)
Visual symptoms	6 (1.5)	31 (2.6)	6 (2.2)	8 (1.9)
Thrombocytopenia	8 (2.0)	44 (3.7)	8 (2.9)	9 (2.1)
Transaminitis	15 (3.8)	88 (7.3)	13 (4.7)	20 (4.7)
Pulmonary edema	2 (0.5)	2 (0.2)	2 (0.7)	1 (0.2)
Eclampsia	2 (0.5)	1 (0.1)	2 (0.7)	0
Renal injury	5 (1.3)	43 (3.6)	5 (1.8)	7 (1.6)
Magnesium sulfate	156 (84.8)	1,040 (95.7)	142 (51.5)	284 (66.2)
ICU admission	2 (0.5)	11 (0.9)	1 (0.4)	4 (0.9)
Neonatal outcome[a]				
Live birth	375 (99.2)	1,124 (98.5)	264 (99.3)	403 (98.1)
Stillbirth	2 (0.5)	11 (1.0)	2 (0.8)	5 (1.2)
Neonatal death	0	6 (0.5)	0	3 (0.7)
Elective termination	1 (0.3)	0	0	0
Male fetal sex[a]	193 (51.1)	578 (50.8)	133 (50.0)	208 (50.7)
APGAR score[a]				
1 min	9 (8-9)	8 (7-9)	8 (8-9)	9 (7-9)
5 min	9 (9-9)	9 (9-9)	9 (9-9)	9 (9-9)
Highest level of neonatal care[a]				
Well baby nursery	260 (68.8)	721 (63.4)	178 (66.9)	256 (62.6)
NICU	115 (30.4)	403 (35.4)	86 (32.3)	148 (36.2)
Not applicable	3 (0.8)	14 (1.2)	2 (0.8)	5 (1.2)
Neonatal birthweight	2,966 ± 723	2,780 ± 786	2,898 ± 740	2,782 ± 797

Values are mean ± SD, n (%), or median (IQR). [a]Multifetal gestations are not included.
BP = blood pressure; ICU = intensive care unit; NICU = neonatal intensive care unit.

95% CI: −8.2, −1.3; doubly robust OR: 0.32; 95% CI: 0.10, 1.01; **Table 2** and **Central Illustration**). When the primary outcome of emergency department visits was evaluated as a per-protocol analysis, the results were similar (RD: −4.8, 95% CI: −8.3 to −1.3; doubly robust OR: 0.29; 95% CI: 0.08-1.05). In the intent-to-treat analysis, the intervention group had a lower adjusted mean difference in systolic blood pressure (−4.4, 95% CI: −6.8 to −2.0), diastolic blood pressure (−3.1, 95% CI: −4.9 to −1.2), and mean arterial pressure (−3.5, 95% CI: −5.4 to −1.7) at 6 weeks postpartum (**Figure 2**, Supplemental Table 3). There was a lower mean systolic and diastolic blood pressure and mean arterial pressure throughout the 6 weeks postpartum in the intervention group compared to the control group (**Central Illustration**).

TABLE 2 Risks of Adverse Maternal Outcomes Among the Tight Blood Pressure Control and Standard Blood Pressure Control Groups Based on the Propensity Score-Matched Analysis

Maternal Outcomes	Tight Blood Pressure Control (n = 276)	Standard Blood Pressure Control (n = 429)	Risk Difference (95% CI)	OR (95% CI)	Doubly Robust OR (95% CI)
Emergency room visit for hypertensive disorders (with or without admission)	10 (3.6)	36 (8.4)	−4.8 (−8.2 to −1.3)	0.39 (0.17-0.91)	0.32 (0.10-1.01)
Discharged on postpartum day	2.7 ± 1.3	2.8 ± 1.4	–	–	–
Antihypertensive medication at discharge	202 (73.19)	199 (46.4)	26.8 (19.8-33.8)	3.71 (2.50-5.53)	6.89 (3.81-12.4)
Labetalol	65 (23.6)	126 (29.4)	−5.8 (−12.4 to 0.8)	0.78 (0.54-1.14)	0.78 (0.48-1.29)
Nifedipine extended release	168 (60.9)	118 (27.5)	33.3 (26.2-40.5)	5.11 (3.38-7.73)	8.78 (4.93-15.6)
Other	4 (1.5)	6 (1.4)	1.1 (−1.6 to 3.7)	1.57 (0.64-3.87)	–
Postpartum visit attendance					
Attended postpartum visits	196 (71.0)	233 (54.3)	–	1.47 (0.70-3.10)	1.37 (0.36-5.24)
Did not attend postpartum visit	18 (6.5)	36 (8.4)	–	–	–
Unknown	62 (22.5)	160 (37.3)	–	–	–
Currently prescribed antihypertensive medication at postpartum visit	109 (55.9)	122 (54.0)	1.9 (−7.6 to 11.4)	1.27 (0.76-2.11)	1.48 (0.63-3.50)
Hospital readmission for hypertensive disorders	4 (1.5)	20 (4.7)	−3.2 (−5.7 to −0.8)	0.24 (0.06-0.99)	0.09 (0.00-2.31)
Unanticipated hospital visit					
Antihypertensive medication adjustment	9 (3.3)	30 (7.0)	−3.7 (−6.9 to −0.5)	–	–
Magnesium sulfate	3 (1.1)	15 (3.5)	−2.4 (−4.5 to −0.3)	–	–
Emergency department visit for any reason (with or without hospitalization)	36 (13.0)	67 (15.6)	−2.6 (−7.8 to 2.7)	0.79 (0.49-1.29)	0.78 (0.45-1.35)
Hospital readmission for any reason	13 (4.7)	28 (6.5)	−1.8 (−5.2 to 1.6)	0.60 (0.27-1.32)	0.36 (0.08-1.59)
Patients withdrawn	25 (9.1)	–	–	–	–

Blood pressure remained lower in the intervention group regardless of the type of hypertensive disorder of pregnancy (Supplemental Figure 1).

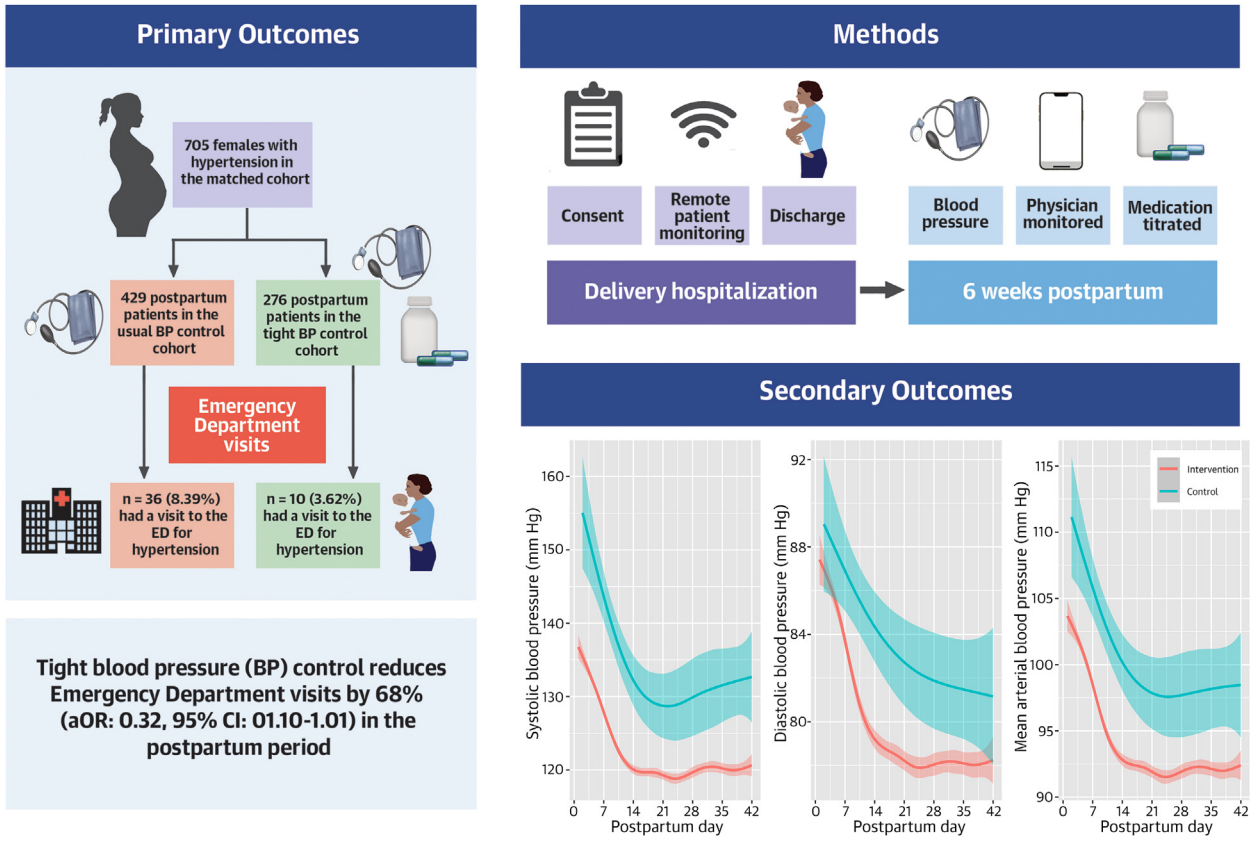
In the intervention cohort, participants took median (IQR) of 8 (5-12), 11 (4-14), 7 (2-13), 5 (1-10), 3 (1-8), and 2 (0-6) blood pressure readings during the first, second, third, fourth, fifth, and sixth week postpartum. The first week was truncated since patients were discharged on postpartum day 2.6 ± 1.3. Compliance with blood pressure readings was 64%, primarily driven by a decrease in blood pressure readings with increasing time in the study. On average, medication was adjusted 1.8 times per patient during the study period, and 75% of patients had one or more adjustments to medication during the first week postpartum. Fourteen (3.6%) patients had persistent blood pressure <100/80 mm Hg during the study period, requiring medication discontinuation. There was one syncopal episode in each cohort and no severe adverse events.

DISCUSSION

This study evaluated the novel intervention targeting a blood pressure goal of <130/80 mm Hg in the postpartum period instead of the current standard of care of <150/110 mm Hg endorsed by American College of Obstetricians and Gynecologists. This tight blood pressure control was associated with a reduction in postpartum emergency department visits by 68%. The intervention group had lower systolic, diastolic, and mean arterial blood pressures at 6 weeks postpartum. There were fewer hospitalizations for hypertensive disorders, and fewer patients received postpartum magnesium sulfate for seizure prophylaxis after initial hospital discharge.

Based on the growing evidence of cardiovascular protection from tighter blood pressure control in the postpartum period, the decision was made to use AHA guidelines for starting or titrating medication.[6,7] However, since blood pressure typically spikes on postpartum days 4 to 6 before decreasing,[15,16] remote patient monitoring was employed to closely monitor and titrate medication. Although the Management of Postpartum Preeclampsia and Hypertensive Disorders protocol used a lower blood pressure target to reduce or discontinue medication than previous studies, it appeared to be safe and well tolerated by patients. This builds on the evidence of a previously published small pilot trial that showed tight blood pressure control to <130/80 mm Hg was safe in the postpartum period.[35] Nevertheless, whether this is safe without remote patient monitoring has not been determined. Previous studies have utilized patient self-titration,[7] which may be more difficult in a population with low health literacy. Further studies must determine if

CENTRAL ILLUSTRATION **Management of Postpartum Preeclampsia and Hypertensive Disorders (MOPP): Postpartum Tight vs Standard Blood Pressure Control**


Primary Outcomes
705 females with hypertension in the matched cohort
429 postpartum patients in the usual BP control cohort
276 postpartum patients in the tight BP control cohort
Emergency Department visits
n = 36 (8.39%) had a visit to the ED for hypertension
n = 10 (3.62%) had a visit to the ED for hypertension
Tight blood pressure (BP) control reduces Emergency Department visits by 68% (aOR: 0.32, 95% CI: 01.10-1.01) in the postpartum period
Methods
Consent
Remote patient monitoring
Discharge
Blood pressure
Physician monitored
Medication titrated
Delivery hospitalization
6 weeks postpartum
Secondary Outcomes
Systolic blood pressure (mm Hg)
Diastolic blood pressure (mm Hg)
Mean arterial blood pressure (mm Hg)
Postpartum day
Intervention
Control

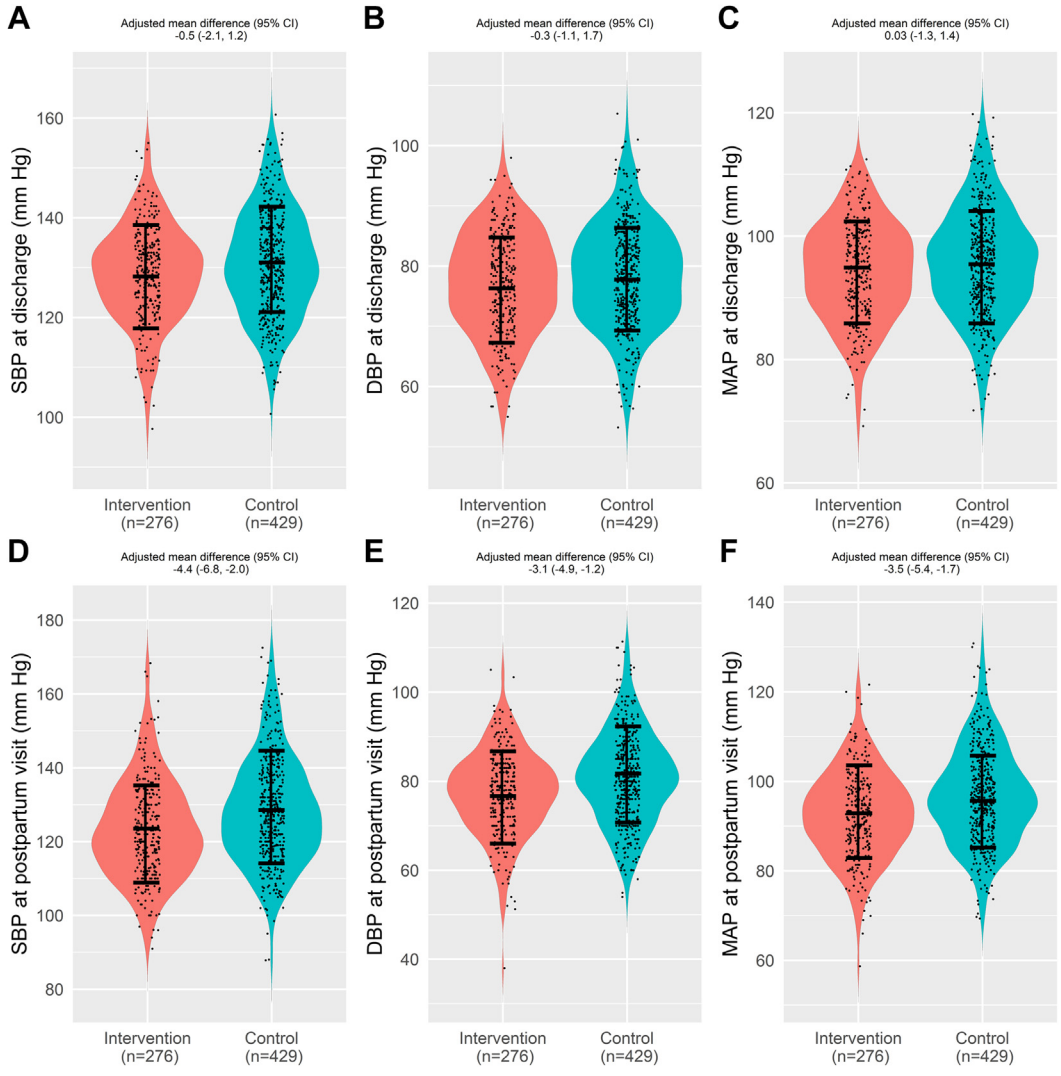
Rosenfeld EB, et al. JACC Adv. 2025;4(3):101617.

Impact of postpartum tight blood pressure control using remote patient monitoring on emergency department visits for hypertensive disorders and blood pressure throughout the 6 weeks Postpartum. In the graph, the intervention and control groups include blood pressure from all emergency department visits, hospitalizations, or postpartum clinic visits. The intervention group additionally consists of all blood pressure readings from the remote patient monitoring. The shaded areas denote the 95% pointwise confidence bands. ED = emergency department.

a lower blood pressure target is safe without intensive remote blood pressure monitoring.

There is a growing body of evidence that lower blood pressure improves cardiovascular health. A meta-analysis of nearly one million patients showed that reducing systolic blood pressure by 10 mm Hg and diastolic blood pressure by 5 mm Hg reduced coronary heart disease by 22% and 41%, respectively.[11] In addition to lowering blood pressure, the study intervention also lowered mean arterial blood pressure, which, in some studies, is an even stronger predictor of cardiovascular health.[36] AHA guidelines currently recommend treating blood pressure to a target of <130/80 mm Hg since numerous studies have shown that this target lowers the risk of coronary heart disease, stroke, and cardiovascular-related death.[12,37] Outside of pregnancy, even a modest decrease in blood pressure can substantially reduce cardiovascular disease.[11] In one of the most extensive studies of postpartum remote patient monitoring, Kitt et al[7] showed a 6.5 mm Hg systolic and 5.8 mm Hg decrease in diastolic blood pressure at 9 months postpartum with self-titration of antihypertensive medication to a blood pressure goal of <150/100 mm Hg. In addition, there was a decrease in left ventricular mass index in those who had self-titrated medication. A follow-up of this study also showed a reduction in cardiac remodeling, which is thought to be associated with better cardiovascular outcomes.[6] On average, these patients only took antihypertensive medications for 40 days, so

FIGURE 2 **Violin Plot of Systolic and Diastolic Blood Pressures and Mean Arterial Pressure Readings, With Mean ± SD, and Adjusted Mean Difference With 95% CIs at Discharge and 6 Weeks Postpartum Comparing the Intervention and Control Groups**



DBP = diastolic blood pressure; MAP = mean arterial blood pressure; SBP = systolic blood pressure.

even a short course of antihypertensive medication in the immediate postpartum period has longstanding cardioprotective effects. There could be additional benefits if this trial were repeated with a lower blood pressure target, such as with the Management of Postpartum Preeclampsia and Hypertensive Disorders protocol.

A previous randomized clinical trial examined initiating medication postpartum before hospital discharge for a blood pressure target of <140/90 mm Hg compared to <150/95 mm Hg and showed no difference in composite maternal morbidity outcomes.[38] However, this study did not examine blood pressure control after discharge from delivery hospitalization. Since blood pressure fluctuates in the immediate postpartum period without frequent titration of medication, the effect of tighter control was likely not detected. This further supports that tighter control should be implemented in the setting of remote patient monitoring studies, such as in Mei et al,[18] where medication was increased for multiple blood pressures >140/90 mm Hg and showed a reduction in hospital visits for hypertensive disorders. The combination of even tighter blood pressure control and remote patient monitoring was a novel approach in this study.

Other remote patient monitoring programs have shown decreased postpartum blood pressure, improved adherence to postpartum visits, and a narrowing of the disparities gap.[15] When looking specifically at emergency department visits, there has been conflicting evidence on whether remote patient blood pressure monitoring decreases emergency department visits and improves maternal outcomes.[18,21] Given the recent data, it may be that tighter blood pressure control with remote patient monitoring is more likely to improve outcomes.

STRENGTHS AND LIMITATIONS. This is one of the first studies to evaluate targeting a blood pressure of <130/80 mm Hg during the postpartum period for patients diagnosed with chronic hypertension and hypertensive disorders of pregnancy. The patient population in this study was diverse in ethnic and racial makeup, primarily publicly insured, were, on average, obese, and were in their early thirties, which is reflective of the patients delivering nationwide. This large, multicenter study implemented a novel approach to treating blood pressure postpartum and showed a reduction in the primary outcome of postpartum emergency department visits for hypertension.

Although a propensity score analysis has methodologic rigor, several limitations are inherent to trials conducted in a nonrandomized fashion. In the retrospective cohort, the mean highest blood pressure during pregnancy was higher than in the prospective cohort, and there were fewer patients with superimposed preeclampsia. This may have been partially driven by the changes in prescribing antihypertensive medications during the antenatal period after the Chronic Hypertension and Pregnancy trial.[13] During the retrospective cohort, the hospital systems transitioned to a new electronic medical record; thus, some data could not be ascertained. Since most of the retrospective cohort had scanned documents, the authors had to depend on billing codes to identify patients. Coders may have been less likely to code for gestational hypertension since there were many fewer patients identified with gestational hypertension in the retrospective cohort. While this study supports tight blood pressure control in the postpartum period, it is also unknown whether it is safe to implement a target of <130/80 mm Hg without remote patient monitoring managed by a physician at all hours of the day. Emergency department visits were chosen as the primary outcome as a surrogate marker for maternal morbidity and mortality. Still, it is unknown if the intervention will decrease the burden of maternal morbidity and mortality.

CONCLUSIONS

In this propensity score analysis of tight blood pressure control compared to usual control in the postpartum period, there was a decrease in postpartum emergency department visits for hypertension. A randomized controlled trial of tight vs standard blood pressure control is needed to determine whether titrating blood pressure medication to a goal of <130/80 mm Hg improves outcomes for postpartum patients.

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REFERENCES

1. Patel S, Rodriguez AN, Macias DA, Morgan J, Kraus A, Spong CY. A gap in care? Postpartum women presenting to the emergency room and getting readmitted. *Am J Perinatol*. 2020;37(14):1385-1392. https://doi.org/10.1055/s-0040-1712170

2. Bruce KH, Anderson M, Stark JD. Factors associated with postpartum readmission for hypertensive disorders of pregnancy. *Am J Obstet Gynecol MFM*. 2021;3(5):100397. https://doi.org/10.1016/j.ajogmf.2021.100397

3. Fasanya HO, Hsiao CJ, Armstrong-Sylvester KR, Beal SG. A critical review on the use of race in understanding racial disparities in preeclampsia. *J Appl Lab Med*. 2021;6(1):247-256. https://doi.org/10.1093/jalm/jfaa149

4. Jaeger BC, Chen L, Foti K, et al. Hypertension statistics for US adults: an open-source web application for analysis and visualization of national health and nutrition examination survey data. *Hypertension*. 2023;80(6):1311-1320. https://doi.org/10.1161/HYPERTENSIONAHA.123.20900

5. Global Cardiovascular Risk C, Magnussen C, Ojeda FM, et al. Global effect of modifiable risk factors on cardiovascular disease and mortality. *N Engl J Med*. 2023;389(14):1273-1285. https://doi.org/10.1056/NEJMoa2206916

6. Kitt J, Krasner S, Barr L, et al. Cardiac remodeling after hypertensive pregnancy following physician-optimized blood pressure self-management: the POP-HT randomized clinical trial imaging substudy. *Circulation*. 2024;149(7):529-541. https://doi.org/10.1161/CIRCULATIONAHA.123.067597

7. Kitt J, Fox R, Frost A, et al. Long-term blood pressure control after hypertensive pregnancy following physician-optimized self-management: the POP-HT randomized clinical trial. *JAMA*. 2023;330(20):1991-1999. https://doi.org/10.1001/jama.2023.21523

8. Hypertension in pregnancy. Report of the American College of Obstetricians and Gynecologists' task force on hypertension in pregnancy. *Obstet Gynecol*. 2013;122(5):1122–1131. https://doi.org/10.1097/01.AOG.0000437382.03963.88

9. American College of O, Gynecologists' Committee on Practice BO. ACOG Practice Bulletin No. 203: chronic hypertension in pregnancy. *Obstet Gynecol*. 2019;133(1):e26–e50. https://doi.org/10.1097/AOG.0000000000003020

10. Walters BN, Walters T. Hypertension in the puerperium. *Lancet*. 1987;2(8554):330. https://doi.org/10.1016/s0140-6736(87)90912-3

11. Law MR, Morris JK, Wald NJ. Use of blood pressure lowering drugs in the prevention of cardiovascular disease: meta-analysis of 147 randomised trials in the context of expectations from prospective epidemiological studies. *BMJ*. 2009;338:b1665. https://doi.org/10.1136/bmj.b1665

12. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association task force on clinical practice guidelines. *J Am Coll Cardiol*. 2018;71(19):e127–e248.

13. Tita AT, Szychowski JM, Boggess K, et al. Treatment for mild chronic hypertension during pregnancy. *N Engl J Med*. 2022;386:1781–1792. https://doi.org/10.1056/NEJMoa2201295

14. Trost SL, Busacker A, Leonard M, et al. *Pregnancy-Related Deaths: Data from Maternal Mortality Review Committees in 38 U.S. States, 2020*. Centers for Disease Control and Prevention, U.S. Department of Health and Human Services; 2024.

15. Palatnik A, Mukhtarova N, Hetzel SJ, Hoppe KK. Blood pressure changes in gestational hypertension, preeclampsia, and chronic hypertension from preconception to 42-day postpartum. *Pregnancy Hypertens*. 2023;31:25–31. https://doi.org/10.1016/j.preghy.2022.11.009

16. Hauspurg A, Lemon L, Cabrera C, et al. Racial differences in postpartum blood pressure trajectories among women after a hypertensive disorder of pregnancy. *JAMA Netw Open*. 2020;3(12):e2030815. https://doi.org/10.1001/jamanetworkopen.2020.30815

17. Hauspurg A, Venkatakrishnan K, Collins L, et al. Postpartum ambulatory blood pressure patterns following new-onset hypertensive disorders of pregnancy. *JAMA Cardiol*. 2024;9:703–711. https://doi.org/10.1001/jamacardio.2024.1389

18. Mei JY, Corry-Saavedra K, Nguyen TA, Murphy A. Standardized clinical assessment and management plan to reduce readmissions for postpartum hypertension. *Obstet Gynecol*. 2023;142(2):384–392. https://doi.org/10.1097/AOG.0000000000005248

19. Suresh SC, Duncan C, Kaur H, et al. Postpartum outcomes with systematic treatment and management of postpartum hypertension. *Obstet Gynecol*. 2021;138(5):777–787. https://doi.org/10.1097/AOG.0000000000004574

20. Hacker FM, Jeyabalan A, Quinn B, Hauspurg A. Implementation of a universal postpartum blood pressure monitoring program: feasibility and outcomes. *Am J Obstet Gynecol MFM*. 2022;4(3):100613. https://doi.org/10.1016/j.ajogmf.2022.100613

21. Arkerson BJ, Finneran MM, Harris SR, et al. Remote monitoring compared with in-office surveillance of blood pressure in patients with pregnancy-related hypertension: a randomized controlled trial. *Obstet Gynecol*. 2023;142(4):855–861. https://doi.org/10.1097/AOG.0000000000005327

22. Niu B, Mukhtarova N, Alagoz O, Hoppe K. Cost-effectiveness of telehealth with remote patient monitoring for postpartum hypertension. *J Matern Fetal Neonatal Med*. 2022;35(25):7555–7561. https://doi.org/10.1080/14767058.2021.1956456

23. Glazer KB, Harrell T, Balbierz A, Howell EA. Postpartum hospital readmissions and emergency department visits among high-risk, medicaid-insured women in New York City. *J Womens Health (Larchmt)*. 2022;31(9):1305–1313. https://doi.org/10.1089/jwh.2021.0338

24. Hinkle SN, Schisterman EF, Liu D, et al. Pregnancy complications and long-term mortality in a diverse cohort. *Circulation*. 2023;147(13):1014–1025. https://doi.org/10.1161/CIRCULATIONAHA.122.062177

25. Grandi SM, Filion KB, Yoon S, et al. Cardiovascular disease-related morbidity and mortality in women with a history of pregnancy complications. *Circulation*. 2019;139(8):1069–1079. https://doi.org/10.1161/CIRCULATIONAHA.118.036748

26. Harris PA, Taylor R, Minor BL, et al. The REDCap consortium: building an international community of software platform partners. *J Biomed Inform*. 2019;95:103208. https://doi.org/10.1016/j.jbi.2019.103208

27. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42(2):377–381. https://doi.org/10.1016/j.jbi.2008.08.010

28. Des Jarlais DC, Lyles C, Crepaz N, Group T. Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: the TREND statement. *Am J Public Health*. 2004;94(3):361–366. https://doi.org/10.2105/ajph.94.3.361

29. Gestational hypertension and preeclampsia: ACOG Practice Bulletin, Number 222. *Obstet Gynecol*. 2020;135(6):e237–e260. https://doi.org/10.1097/AOG.0000000000003891

30. Mitro SD, Hedderson M, Xu F, et al. Risk of postpartum readmission after hypertensive disorder of pregnancy and variation by discharge antihypertensive medication prescription. *Am J Obstet Gynecol*. 2024;231:456.e1–456.e13. https://doi.org/10.1016/j.ajog.2024.01.015

31. Do SC, Leonard SA, Kan P, et al. Postpartum readmission for hypertension after discharge on labetalol or nifedipine. *Obstet Gynecol*. 2022;140(4):591–598. https://doi.org/10.1097/AOG.0000000000004918

32. van Buuren S. Multiple imputation of discrete and continuous data by fully conditional specification. *Stat Methods Med Res*. 2007;16(3):219–242. https://doi.org/10.1177/0962280206074463

33. Rubin DB. *Multiple Imputation for Nonresponse in Surveys*. Wiley; 1987.

34. Austin PC. An Introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multiv Behav Res*. 2011;46(3):399–424. https://doi.org/10.1080/00273171.2011.568786

35. Sarma AA, Crousillat DR, Del Cueto P, et al. Feasibility of virtual blood pressure monitoring titrated to ACC/AHA thresholds among outpatients with postpartum hypertension. *JACC Adv*. 2023;2(5):100390. https://doi.org/10.1016/j.jacadv.2023.100390

36. Mosley WJ 2nd, Greenland P, Garside DB, Lloyd-Jones DM. Predictive utility of pulse pressure and other blood pressure measures for cardiovascular outcomes. *Hypertension*. 2007;49(6):1256–1264. https://doi.org/10.1161/HYPERTENSIONAHA.106.083592

37. Thomopoulos C, Parati G, Zanchetti A. Effects of blood pressure lowering on outcome incidence in hypertension: 7. Effects of more vs. less intensive blood pressure lowering and different achieved blood pressure levels - updated overview and meta-analyses of randomized trials. *J Hypertens*. 2016;34(4):613–622. https://doi.org/10.1097/HJH.0000000000000881

38. Aderibigbe OA, Hackney DN, Ranzini AC, Lappen JR. Tight vs liberal control of mild postpartum hypertension: a randomized controlled trial. *Am J Obstet Gynecol MFM*. 2023;5(2):100818. https://doi.org/10.1016/j.ajogmf.2022.100818

KEY WORDS **hypertension, postpartum, preeclampsia**

APPENDIX **For supplemental tables and figures, please see the online version of this paper.**